Combined pressure temperature effects on lycopene stability and isomerization in tomato juice

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Abstract

Lycopene is a carotenoid predominant in tomatoes. In the present study, effects of combined pressure and temperature (500, 600 and 700 MPa; 30^{0}C and 100 ^{0}C) on lycopene stability and isomerization in cold extracted tomato juice have been investigated. The initial temperature of the pressure treated samples was adjusted taking heat of compression of samples into account. Processed samples were refrigerated at 4^{0}C for less than 3 days before extraction and quantification of lycopene. Reverse phase High Performance Liquid Chromatography was employed to separate *cis* and *trans* isomers and quantify total lycopene. The total extractable lycopene content increased as the pressure was increased from 500-700 MPa at 30^{0}C. Combined pressure and temperature (500-700 MPa at 100^{0}C) treatment showed synergistic effects resulting in an increase in the total extractable lycopene content in tomato juice as compared to the raw juice, pressure, and temperature controls. Treatment at 500 MPa 100^{0}C for 10 min showed maximum increase in the all *trans* isomer of lycopene (7.40 ± 0.50 mg lycopene/100 g tomato juice). Although temperature control at 100^{0}C for 10 min resulted in maximum *cis* isomer formation of lycopene (0.48±0.01 mg *cis* isomer/100 g tomato juice), PATP treatments showed little difference (0.43-0.47 mg *cis* isomer/100 g tomato juice). This study suggests that PATP has the potential of being used as a tool to produce high quality shelf stable tomato products with increased extractable lycopene content. We hypothesize that these PATP treatments will also result in enhanced bioavailability of lycopene.

Introduction

•Pressure Assisted Thermal Processing is a novel minimal processing technology that combines extremely high pressures (500-700 MPa) and temperatures between 90-120 ^{0}C for a short period of time (3-10 min.) to obtain high quality shelf stable foods with minimum impact of temperature on quality. (1).

•Lycopene ($C_{40}H_{56}$) is a carotenoid predominant in tomatoes and over 80% of it in the American diet comes from tomato and tomato products.

•Epidemiological studies have shown that dietary intake of tomato and tomato products have been inversely associated with the incidence of prostate cancer.

•Lycopene exists in *cis* and all-*trans* configuration with all-*trans* making up 79-91% of total lycopene in tomato and tomato based products. However, it is suggested that *cis* isomers of lycopene are better absorbed in the body than the all-trans isomers (2).

•Known to be fairly stable to heat, lycopene is susceptible to destruction by oxygen and light (2).

•Pressure pasteurization (300-600 MPa at or near room temperature) effects on lycopene stability have been reported in the literature. However the fate of lycopene under PATP conditions is not well understood.

Objectives

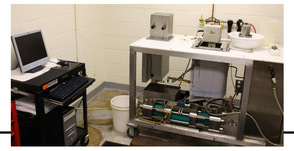
1. The aim of this study is to investigate combined High Pressure-Temperature induced effects on
   a. Lycopene stability in tomato juice
   b. Lycopene isomerization in tomato juice

Methods

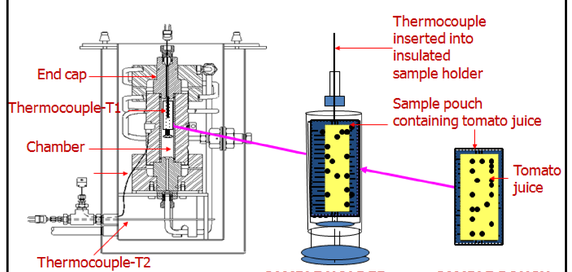
Juice Extraction
(Juiceman Jr. Lab Juicer)

High Pressure Proc.
(500-700 MPa, 30^{0}C)

Pressure Assisted Thermal Processing
(500-700 MPa 100 ^{0}C)



Pressure equipment

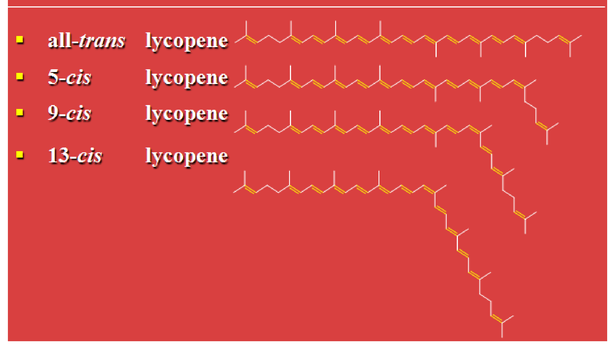


Processed | Sample

High Performance Liquid Chromatography

Data Analysis

Selected Geometrical Isomers of Lycopene



Results and Discussion

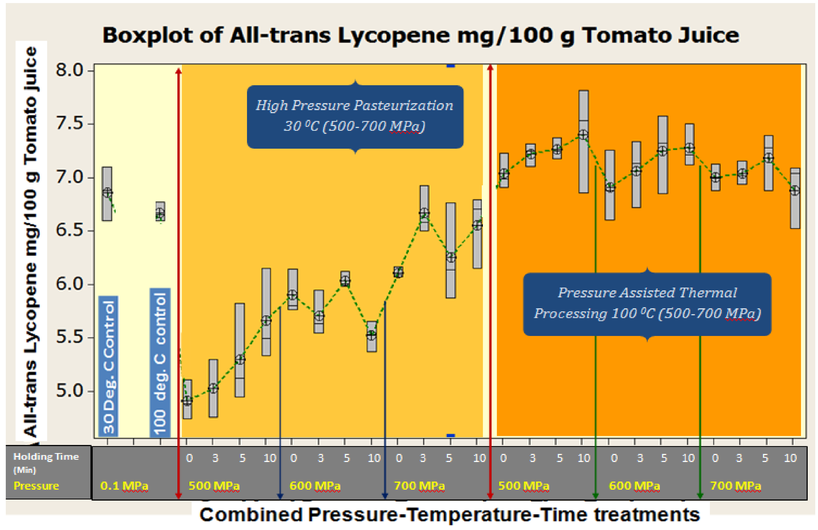


Fig. 1 Changes in the extractable all-*trans* Lycopene from tomato juice exposed to Combined treatments of pressure-temp. and time.

In general, lycopene extractability in tomato juice treated using Pressure Assisted Thermal Processing (PATP) is significantly greater than the fresh tomato juice (30 ^{0}C control) and thermally treated (100 ^{0}C control) tomato juice(P<0.1). Isomerization of lycopene in PATP treated juice and thermally processed juice (100 ^{0}C control) is comparable.

Also, lycopene extractability and isomerization in High Pressure Pasteurized tomato juice is significantly lesser than the fresh tomato juice (30 ^{0}C control) and thermally treated (100 ^{0}C control) tomato juice (P<0.1) (Exception – 700 MPa, 10min. holding time).

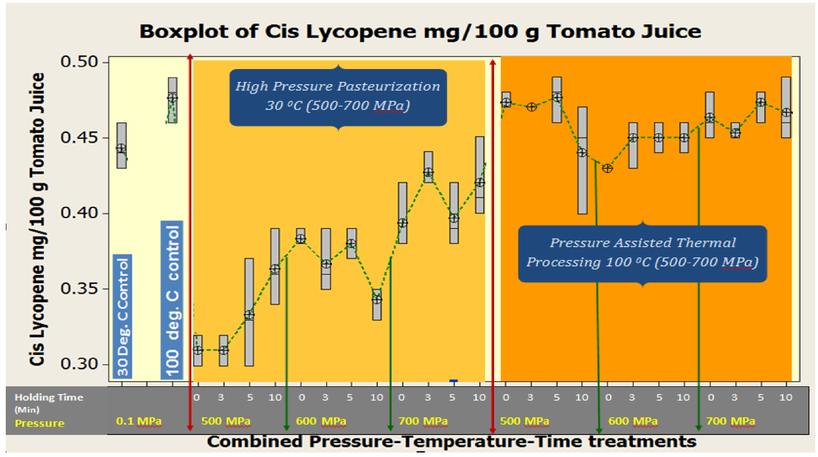


Fig. 2 Changes in the extractable *cis* Lycopene from tomato juice exposed to Combined treatments of pressure-temp. and time.

Conclusions

1. The increase in all-*trans* lycopene extractability in PATP processed tomato juice samples is significantly greater (P<0.1) than the fresh raw juice and temperature controls.
2. The increase in the *cis* isomer of lycopene after PATP treatments is significantly greater than the raw tomato juice and comparable to the *cis* isomer content of thermally treated tomato juice at 100 ^{0}C for 10 min.
3. PATP has the potential of being used as a tool to produce high quality shelf stable tomato products with increased extractable lycopene content.

Acknowledgements

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References

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